WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Tensleep Creek Instream Flow Report

PROJECT: IF-2286-09-8601

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Studies were begun in August 1985 and continued through the 1986 field season to obtain instream flow information from a portion of Tensleep Creek. The studies were designed to provide results which could be used to determine instream flow needs for trout as well as to evaluate potential flow-related impacts which could result from the proposed Federal Energy Regulatory Commission (FERC) project at this site. All data except existing fish population data have been collected. Data to document the nature of the existing fishery will be collected over the next 2-3 years or until the project is built.

METHODS

All of the field data used in this study were collected from a 315 foot long study site located about 1/4 mile upstream from the mouth of Leigh Creek at R87W, T48N, S34, SW1/4. This site contained a combination of pool and riffle habitat for trout that was representative of trout habitat features found throughout this portion of the stream. Results and recommendations apply to a portion of the stream extending from a downstream boundary at the west section line of section 4, R87W, T48N upstream to the confluence of East and West Tensleep Creeks in R86W, T48N, SW1/4.

A physical habitat simulation model (PHABSIM) developed by the Instream Flow Service Group of the Fish and Wildlife Service (Bovee and Milhous 1978) was used to identify incremental changes in the amount of physical habitat for rainbow trout with changes in flow. Data were collected at seven transects which were placed across each habitat type within the study segment. Velocities and depths were measured at 1 to 2 foot intervals across each transect during three different flow events (Table 1). These data permitted accurate simulation of physical habitat over a range of flows between 20 and 435 cfs.

The PHABSIM model can be used to quantify habitat changes for a variety of species and up to five live stages of fish. For the above-defined stream segment, analyses were made of habitat changes for rainbow trout adult, juvenile and fry life stages (combined). The model was used for rainbow trout since the stream is dominated by this species. Recommendations were not provided for spawning and incubation useable area because analyses showed very limited amounts of useable area for spawning over the entire range of flows.

Table 1. Dates and discharges when instream flow data were collected on Tensleep Creek.

Date	Discharge (cfs)	PHABSIM	HQI
08-06-85	39	-	X
07-02-86	174	X	X
07-22-86	70	X	X
09-09-86	50	X	X

Most of the recruitment to this fishery is assumed to come from upstream tributaries to Tensleep Creek and fish stocked by the Department.

The Habitat Retention method (Nehring 1979) was used to identify a flow for maintaining adequate levels of aquatic insect production and fish passage through riffle areas. Data from single transects placed across four riffles within the study area were analyzed in the IFG-1 computer program (Milhous 1978). Flow data were collected on the same dates as the PHABSIM data were collected (Table 1). The flow recommendation for this method was determined by identifying the discharge at which two of the three hydraulic criteria in Table 2 were met at all riffle cross-sections.

Table 2. Hydraulic criteria used to obtain an instream flow recommendation using the Habitat Retention method for Tensleep Creek.

Category	Criteria
Average Depth (ft)	0.50
Average Velocity (ft per sec)	1.00
Wetted Perimeter (percent)*	60

* - Compared to wetted perimeter at bank full conditions.

The Habitat Quality Index (HQI) developed by the Wyoming Game and Fish Department (Binns and Eiserman 1978) was used to estimate potential changes in trout standing crops under various levels of late summer flow conditions. This model incorporates seven attributes that address chemical, physical as well as biological components of trout habitat. Results are expressed in habitat units (HU) per acre. The estimates derived from this model are based on and apply only to late summer flow conditions. By measuring habitat attributes at various flow events as if associated habitat features were typical of late summer flow conditions, HU estimates can be made for a range of theoretical late summer flows.

Results from the Habitat Retention, HQI and PHABSIM (adult, juvenile and fry life stages) models were combined to identify the flow needed to maintain existing levels of trout production throughout the year. Natural undepleted flows during this time period (primarily October to April) that are less than the recommended discharge will maintain trout survival at its current level since the existing trout population has evolved under these conditions. The results presented here are useful to illustrate the critical nature of those flows for trout survival.

RESULTS

Results from the habitat retention model showed that flows of 7,9,18 and 22 cfs are necessary to maintain aquatic insect production and fish passage at the four riffles in the study area (Appendix A). The maintenance flow derived from this method is defined as the flow at which two of the three hydraulic criteria are met for all riffles in the study site; which in this case is 22 cfs.

Results from the PHABSIM analysis for adult, juvenile and fry rainbow trout showed that useable area in the stream is maximized at 40 cfs for the range of flows considered (Figure 1). The average percent of useable area for these three life stages decreases from 14 percent at 40 cfs to 21 percent at 22 cfs. At flows less than 20 cfs, useable area for rainbow trout decreases rapidly.

August and September stream flows usually approximate the 39 cfs flow that was measured on August 6, 1985 (Table 1). Therefore, the management objective for this stream segment is to maintain approximately 135 HU's per acre - the number which were determined to presently exist in the study area (Figure 2). To better define the potential habitat quality and standing crop of trout at flows less than 39 cfs, data for an HQI at 22 cfs were simulated and run through the model. The results from this analysis indicate that trout habitat units would decrease to about 105 HU's per acre.

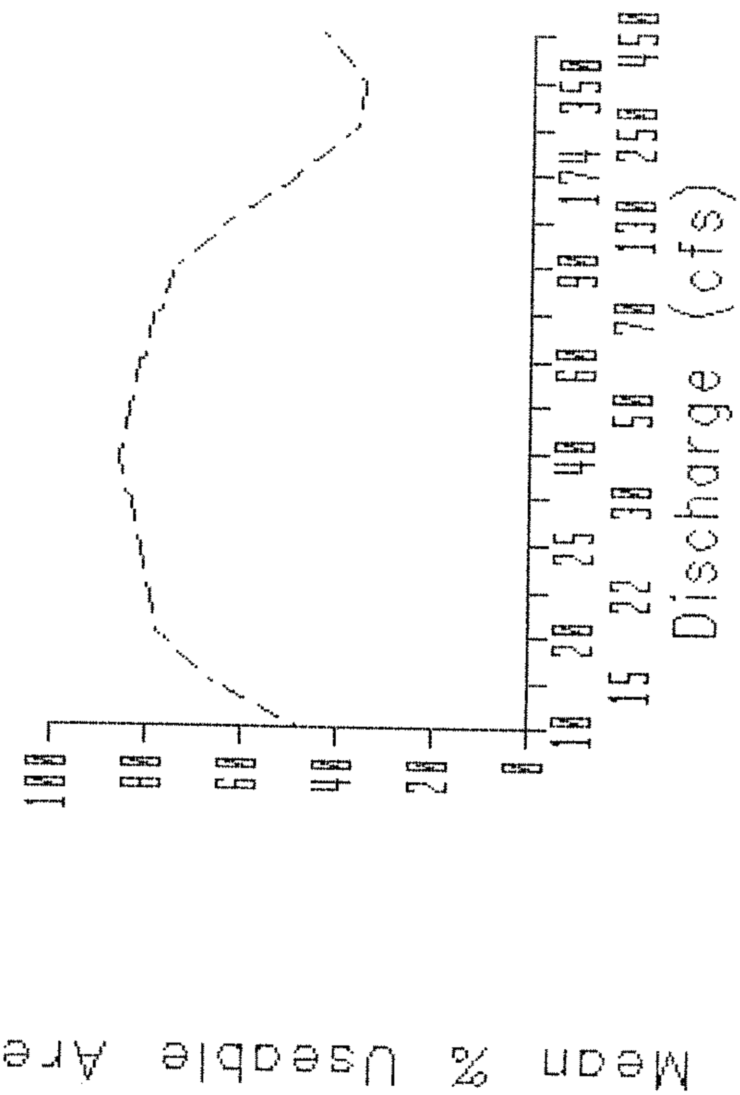

Figure 1. Change in mean percent useable area for adult, juvenile and fry rainbow trout with incremental changes in stream flow.

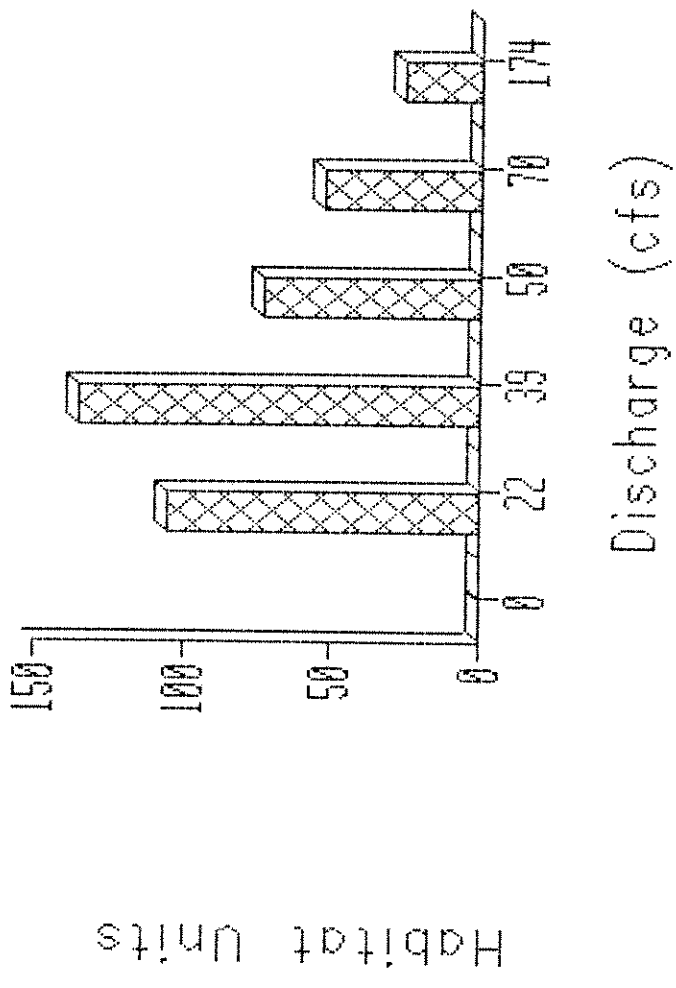

Figure 2. Estimated numbers of trout habitat units at five different flows.

This decrease in HU's is generally supported by the results from the PHABSIM model. If July to September flows were to be increased above existing levels, trout densities would similarly decrease from current levels.

On this basis an instream flow of at least 22 cfs between July 1 and September 30 is recommended to maintain existing levels of trout production.

It is a well documented fact that substantial mortality of wild trout occurs in the winter, particularly in relatively high elevation streams like those found throughout Wyoming. Needham et. al (1945) documented overwinter losses of brown trout ranging up to 85 percent and averaging over 60 percent in a California stream. Butler (1979) reported significant trout and aquatic insect losses caused by anchor ice formation. Reimers (1957) considered anchor ice, collapsing snow banks and fluctuating flows resulting from the periodic formation and breakup of ice dams to be the primary causes of trout winter mortality. These studies were all conducted on unregulated streams and illustrate the severe conditions that trout are exposed to naturally during the winter. The causes of winter mortality discussed above are all greatly influenced by the quantity of winter flow in terms of its ability to minimize anchor ice formation (increased velocity and temperature loading). Higher flows also serve to dilute and prevent snow bank collapses and ice dam formation respectively. Any reduction of natural winter stream flows would increase trout mortality and effectively reduce the number of fish that the stream could support. The fishery management objective for the time period from October 1 to March 31 is to protect all available natural stream flows in the instream flow segment.

The Habitat Retention method was developed to identify a flow that would maintain aquatic insects in riffle areas and provide passage for trout between different habitat types in the stream. Maintenance of these features is as important during the winter as it is during the summer and, as a consequence, the recommendation derived from this method (22 cfs) is applied to the period between October 1 and March 31.

Preliminary analyses indicate that the recommended winter instream flow is seldom found in the portion of Tensleep Creek addressed by these studies. Since Tensleep Creek supports an excellent fishery with these flow conditions, this does not indicate a need for storage to provide the recommended flow. Instead it shows that the entire available natural flow is needed throughout the winter to maintain trout survival at its present level.

Results from the PHABSIM model show that the amount of useable area in the study area for spawning rainbow trout is extremely limited (Table 3). This is due primarily to the very limited amount of spawning gravels and excessive flow conditions experienced during spring runoff (high velocities) in this portion of the stream. Any reduction in flows during spring runoff (whenever flows exceed about 130 cfs) would increase the useable area for spawning somewhat. The majority of the trout recruitment to this portion of the stream undoubtedly originates in upstream tributaries and from Game and Fish Department hatchery plants. Subsequently an instream flow right to enhance natural reproduction in this part of the stream cannot be justified. An instream flow to maintain motile life stages (adult, juvenile and fry), however, is still needed during this time. This recommendation is derived from the Habitat Retention and PHABSIM model results and is the same recommendation as applied to all other times of year (22 cfs).

Table 3. Comparison of weighted useable area for rainbow trout spawning with total surface area in the study area.

Discharge (cfs)	Fry WUA (sq ft)	Total Area (sq ft)
10	0	31383
15	0	32896
20	2	34378
22	3	34782
25	8	35183
30	24	35760
40	60	36793
50	67	37509
60	79	38097
70	95	38667
90	139	39902
130	194	42431
174	165	44049
250	64	45944
350	8	47541
450	0	48008

CONCLUSIONS

Based on the analyses and results contained in this report, a year round instream flow recommendation of 22 cfs applies to approximately 8.1 miles of Tensleep Creek on National Forest lands upstream from the western section line of section 4, T47N, R87W to the confluence of East and West Tensleep Creeks in R86W, T48N, S6, SW1/4 (Table 4.)

Table 4. Summary of instream flow recommendations for Tensleep Creek.

Time Period	Instream Flow Recommendation (cfs)
July 1 to September 30	22
October 1 to September 31	22
April 1 to June 30	22

LITERATURE CITED

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APPENDIX A

Table 5. Results from Habitat Retention method for riffle 1.

Disch*	Avg Dep*	Avg Vel*	Wet Per*
4.8	0.4	0.35	54.6
6.8	0.45	0.39	60.1
10.3	0.57	0.46	69.9
16.1	0.69	0.57	73.7
23.8	0.81	0.69	76.4
30.2	0.88	0.78	79.3
33.9	0.9	0.82	82.3
42.3	0.98	0.92	83.8
48.9	1.04	0.99	85.5
51.1	1.05	1.02	88.5

* - Discharge (cfs)
Average Depth (ft)
Average Velocity (ft per sec)
Wetted Perimeter (percent of bank full)

Table 6. Results from Habitat Retention method for riffle 2.

Disch	Avg Dep	Avg Vel	Wet Per
0.34	0.42	0.12	13.1
4.8	0.55	0.47	36.7
14.6	0.67	0.75	57.4
17.8	0.7	0.79	59.9
20.8	0.74	0.86	64.2
28.7	0.83	0.98	69.7
30.3	0.87	0.99	71.8
35.1	0.9	1.06	72.3
38.7	0.93	1.11	73.7
46.7	1.01	1.21	75.9

Table 7. Results from Habitat Retention method for riffle 3.

Disch	Avg Dep	Avg Vel	Wet Per
3.2	0.52	0.37	39.8
6.1	0.61	0.48	50.1
9.1	0.64	0.56	59.5
9.3	0.65	0.57	60.1
13.1	0.73	0.66	65.2
16.4	0.81	0.73	67.1
20.4	0.91	0.81	68.6
25.2	0.98	0.89	69.9
31.5	1.06	0.99	72.1
33.8	1.09	1.04	72.9

Table 8. Results from Habitat Retention method for riffle 4.

Disch	Avg Dep	Avg Vel	Wet Per
1.8	0.44	0.22	35.3
3.1	0.51	0.31	38.2
4.8	0.57	0.41	41.2
7.3	0.62	0.52	44.7
10.7	0.67	0.65	48.2
15.1	0.73	0.81	51.5
20.8	0.72	0.95	59.2
21.5	0.72	0.97	59.9
23.2	0.73	0.99	67.2
32.1	0.75	1.19	69.8